REMARKS

Claims 1-22 remain pending. Independent claims 1, 18, 21, and 22 have been amended in the manner indicated above.

As described in the specification of the instant patent application, embodiments in accordance with the present invention relate to methods for forming a refractory metal nucleation layer over a barrier through "alternating exposure" to silicon containing and refractory metal containing gases:

> [t]he phrase "alternating exposure" refers to a process sequence wherein: (a) tungsten layer 22 is exposed to $SiH_4$ to form a silicon layer on tungsten layer 22; (b) the $SiH_4$ is purged from a reactor, in which the inventive process is being conducted; (c) the tungsten layer (which has been exposed to $SiH_4$ and, therefore, has a silicon layer on its surface) is exposed to $WF_6$ such that the $WF_6$ is reduced by the silicon layer, thus depositing additional tungsten on tungsten layer 22; (d) the $WF_6$ is purged from the reactor; and (e) steps (a) through (d) are then repeated as necessary to form a tungsten nucleation layer of a desired thickness. (Emphasis added; page 7, lines 13-20).

Purging of silicon containing gas and refractory metal containing gas after their respective exposure to the semiconductor workpiece, avoids the changed chamber pressure that may otherwise be necessary to suppress particle formation:

> process conditions used to form the tungsten nucleation layer can be conducted at a relatively high pressure (i.e., at a pressure in the range of 40 Torr to 300 Torr). This pressure produces a fast deposition rate and thus increases process throughput in comparison to conventional processes for the formation of a tungsten nucleation layer. Furthermore, by avoiding the simultaneous presence of $WF_6$ and $SiH_4$ in the process chamber, gas phase nucleation and hence particle formation is avoided even though the process is conducted at a relatively high pressure. (Emphasis added; page 8, lines 22-29)

In order to emphasize this aspect of embodiments in accordance with the present invention, independent claims 1, 18, and 21-22 have now been amended to recite gas purging between alternating exposure steps.

The Examiner has rejected claims 1-22 either as either anticipated under 35 U.S.C. 102 by U.S. Patent No. 6,287,964 to Cho ("the Cho patent"), or obvious under 35 U.S.C. 103 by the Cho patent considered in light of U.S. Patent No. 6,107,200 to Takagi et al. ("the Takagi patent") and U.S. Patent No. 6,498,399 to Chung et al. ("the Chung patent"). These claim rejections are traversed as follows.

The Cho patent describes methods for forming a tungsten layer over a barrier layer. However, unlike the pending claims, the Cho patent describes a process wherein silicon containing and tungsten containing gases are present at the same time.

> As shown in FIG. 2D, $SiH_4$ gas and $WF_6$ gas flow on the amorphous silicon layer 15, and a first tungsten layer 16 is deposited on the amorphous silicon layer 15. The reaction path is $3SiH_4$ (gas)+$2WF_6$2W+$3SiF_4$ (gas)+$6H_2$ (gas). Note that the amorphous silicon layer 15 and the first tungsten layer 16 can be formed by first introducing $SiH_4$ gas into the reaction chamber for a period of time necessary to form the amorphous silicon layer 15, then also introducing the $WF_6$ gas to form the first tungsten layer 16. (Emphasis added; col. 4, lines 42-50)

Nowhere does the Cho patent teach or even suggest purging the silicon containing gas and tungsten containing gas to prevent their simultaneous presence in the processing chamber.

Moreover, none of the other patents also relied upon by the Examiner teaches or suggests such a process flow. For example, the Chung patent relates only generally to formation of barrier layers comprising different materials such as titanium or tantalum. This patent does not teach or even suggest a process for forming tungsten over such barrier layers in a manner which avoids the simultaneous presence of silicon containing and refractory metal containing gases in the processing chamber.

The Takagi patent focuses upon formation of a Tungsten layer utilizing diborane as a reducing agent. In each case where a silicon containing gas (monosilane) is described as being flowed into the chamber, it is accompanied by a tungsten containing gas. (See col. 5, lines 30-32, col. 4, line 67 - col. 6, line 2, col. 6, lines 20-22, col. 6, lines 55-56, and col. 9, lines 48-60). Moreover, the simultaneous flow of silicon and tungsten

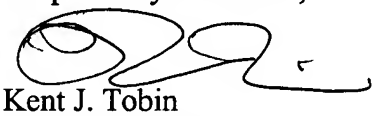
containing gases taught by the Takagi patent is performed at a substantially lower pressure (3 Torr) than that of subsequent processing steps (80 Torr).

This dramatic change in pressure required by the Takagi patent, and the attendant undesirable throughput reduction, is explicitly recognized by the instant patent application as disadvantage of the prior art. Accordingly, the claimed embodiments are specifically intended to avoid the requirement of such a changed pressure by ensuring that silicon containing and tungsten containing gases are purged and thus not present in the chamber at the same time.

Because none of the patents relied upon by the Examiner describe or even suggest a process in which silicon containing gases and refractory metal containing gases are not simultaneously present within the processing chamber, it is respectfully asserted that the pending claims are not anticipated or obvious in view of these references.

Applicants believe all claims now pending in this Application are in condition for allowance. Issuance of a formal Notice of Allowance at an early date is thus respectfully requested. If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at (650) 326-2400 x5423.

Respectfully submitted,



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